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Saint-Hilaire virtual herbarium, a new upgradeable tool to study Brazilian botany

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ABSTRACT

The new Franco-Brazilian website “Saint-Hilaire virtual herbarium” offers dynamic online consultation of all specimens and manuscripts of the naturalist Auguste de Saint-Hilaire, providing links between specimen images and associated textual data, including notes available in his field books. This tool aims at facilitating the work of taxonomy and systematic botany and allowing a more accurate reconstruction of the routes and time frame of Saint-Hilaire’s exploration. All specimens are being digitized by the Paris herbarium (P) and added online. The system will also offer Saint-Hilaire’s major publications online. The nomenclature and determinations are automatically updated through dynamic links to the SONNERAT/MNHN database. In this paper, we propose moreover a standard for the correct citation of Saint-Hilaire specimens.

KEY WORDS

Saint-Hilaire,
Virtual herbarium,
Field notes,
Brazil,
website.

RÉSUMÉ

L'herbier virtuel A. de Saint-Hilaire, un nouvel outil évolutif pour étudier la botanique du Brésil.

Le nouveau site franco-brésilien « Herbier Virtuel A. de Saint-Hilaire » permettra une consultation dynamique de l'ensemble des spécimens et des manuscrits du naturaliste Auguste de Saint-Hilaire, en offrant un lien entre les photos des spécimens et les données associées qui figurent sur les cahiers de récoltes. Cet outil facilitera le travail de taxonomie et de systématique botanique et donnera la capacité à reconstituer avec précision les trajets et la chronologie des explorations de Saint-Hilaire. L'ensemble des spécimens sera progressivement mis en ligne à la suite de la numérisation de l'herbier de Paris (P). Le site mettra également à disposition les principales publications de Saint-Hilaire. La nomenclature et les déterminations sont maintenues à jour de façon dynamique par un lien avec la base de données SONNERAT du MNHN. Dans ce travail, nous proposons en outre un standard pour la citation correcte des spécimens de Saint-Hilaire.

MOTS CLÉS

Saint-Hilaire,
Herbier virtuel,
Cahiers de récoltes,
Brésil,
Site web.

INTRODUCTION

Auguste de Saint-Hilaire (1779-1853; Fig. 1) has a special place in Brazil's history. He was one of the first botanists to explore the states of Rio de Janeiro, Espírito Santo, São Paulo, Minas Gerais, Goiás, and from the state of Rio Grande do Sul to the "Banda oriental del Uruguay" between 1816 and 1822. Apart from his botanical collections, Saint-Hilaire also collected important zoological material and provided original data on the geography and culture of Brazil. His work constitutes a primary source for historians.

His name is better known in Brazil than in France, where his work is somewhat forgotten and where it must withstand the competition of his namesakes Étienne and Isidore Geoffroy Saint-Hilaire. In Brazil, districts, natural reserves, science centres, and even a brand of cachaça bear his name, and his portrait appears on the bottle.

HISTORY

Upon his arrival in Brazil in 1816, Saint-Hilaire was already a confirmed botanist. Between 1810 and 1816, he published more than 20 contributions to botany.

His early work (Saint-Hilaire 1811) is a passionate presentation of the context of the time, when he criticized how the "*Gens du Monde*", the cultural elite of the time, perceived that science was influenced by the work of Jean-Jacques Rousseau.

At the end of six years of exploration in South America, he returned to France. He published his work about Brazilian botany, geography and uses of plants until the end of his life (Brandão et al. 2012). His work encouraged European scientists to invest in and train the Brazilian elite.

His two major works are the *Flora brasiliae meridionalis*, Brazil's first flora (Saint-Hilaire et al. 1825-1833) and his travel's reports, *Voyages dans l'intérieur du Brésil* (Saint-Hilaire 1830, 1833, 1847, 1848, 1851 and 1887). He witnessed the beginning of the destruction of the Brazilian Atlantic forest as reported in his writings.

Saint-Hilaire's plant collections are difficult to consult because they are often distributed in larger herbaria (i.e. *Herbier Général* in Paris). Despite that, these specimens should be constantly consulted by taxonomists working in Brazil, because they are essential historical material. Unfortunately, data on the specimen labels are succinct.



FIG. 1. — Auguste de Saint-Hilaire (1779-1851), a few years after his trip to Brazil. (Photo, F. Bouazzat, MNHN).

TABLE 1. — The system sends a request twice a day to the Sonnerat database.

Images		
Field notebooks	Number of images	MBytes
A1	136	4408
A2	182	2363
B1	494	7318
B1 bis	24	703
B2	204	2825
B4 bis	41	391
C1	408	6011
C2	284	8633
C3	106	1401
D	164	3303
Total	2043	37356
Exsicatas		
CLF	636	4187
P	6197	1015579
Total	6833	1019766
Database		
records		7634
records with images		5753 (75%)
records of types		3098
records of types with images		2077 (67%)
collects		5146
determinations		13907
distinct families		169
distinct genera		1118
distinct species		4161
last update		3/6/2013, 7:08

Complete elements are available in handwritten field books drafted in old French handwriting which is especially difficult for non-francophone speakers. For this reason these catalogues remain largely unknown.

NUMBER OF SAINT-HILAIRE COLLECTIONS

It is estimated that there are nearly 8900 collection numbers. There are about 3300 records in the SONNERAT database, and 1350 specimens without any number. We estimate (data of 2012) that only about 37% of the collection is registered in the database. The location of Saint-Hilaire's entire collection may take years to find. Scanning of all vouchers and digitization of the data held at the herbarium in Paris (six million digital images) will certainly accelerate the process.

A short presentation of Saint-Hilaire's virtual herbarium was made by Romaniuc Neto & Pignal (2010) during Brazil's National Congress of Botany held in Manaus in 2010.

Other herbaria also hold specimens from Saint-Hilaire's collection such as Montpellier (MPU), Clermont-Ferrand (CLF) and Autun (AUT), as well as several foreign institutions, such as B (a lot has been destroyed), F, US, and others. It is difficult at present to find all of the Brazilian material deposited, but the website may be used to complement the data available. Plants that Saint-Hilaire collected in France were sent to many correspondents and are even more difficult to locate.

The most famous collection besides Paris that is of great botanical interest concerning Saint-Hilaire's holdings is the herbarium Cambessèdes at Montpellier University. Jacques Cambessèdes, together with Adrien de Jussieu and Saint-Hilaire, was the author of the *Flora Brasiliae meridionalis*, the first systematic treatment of the Brazilian flora (Saint-Hilaire *et al.* 1825-1833).

WEBSITE PRESENTATION

The website "A. de Saint-Hilaire virtual herbarium" (<http://hvsh.cria.org.br>) aims at:

- organizing and presenting Saint-Hilaire's botanical work;
- allowing dynamic access to the data available at the SONNERAT database;
- associating all images from Saint-Hilaire's collection digitized during the renovation of Paris Herbarium.

All website pages are available in Portuguese, French and English, tabs allow the change of language. The site consists of four parts: "Project presentation", "History", "Works" and "Virtual Herbarium" (see Fig. 2). The historic part provides biographic works about Saint-Hilaire. The "works part" presents most of Saint-Hilaire's manuscripts and published work. In the near future, all books written by Saint-Hilaire will be available.

The "Virtual herbarium" presents the voucher and field books' images. The system includes tools for image handling and measurement of specimens.

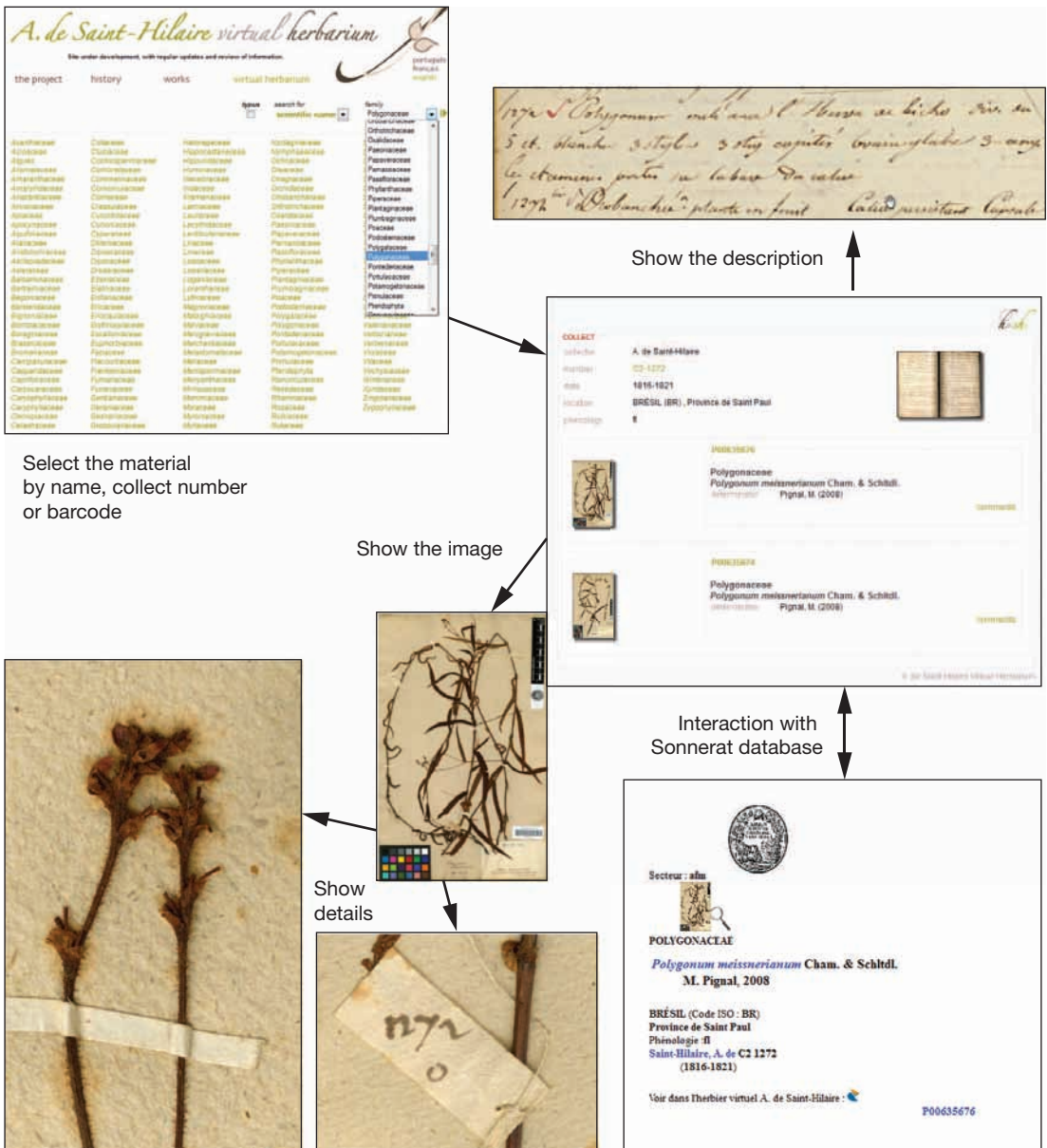


Fig. 2. — Operations with the virtual herbarium interface. It is possible to select the name, collection number or barcode. The collection shows two specimens and a description.

LINK WITH THE SONNERAT DATABASE
 SONNERAT is the database of the Paris Herbarium and many other herbaria in France (French

herbaria network) coordinated by the Muséum national d'Histoire naturelle (MNHN). Every time a new sheet is recorded, or a new determination

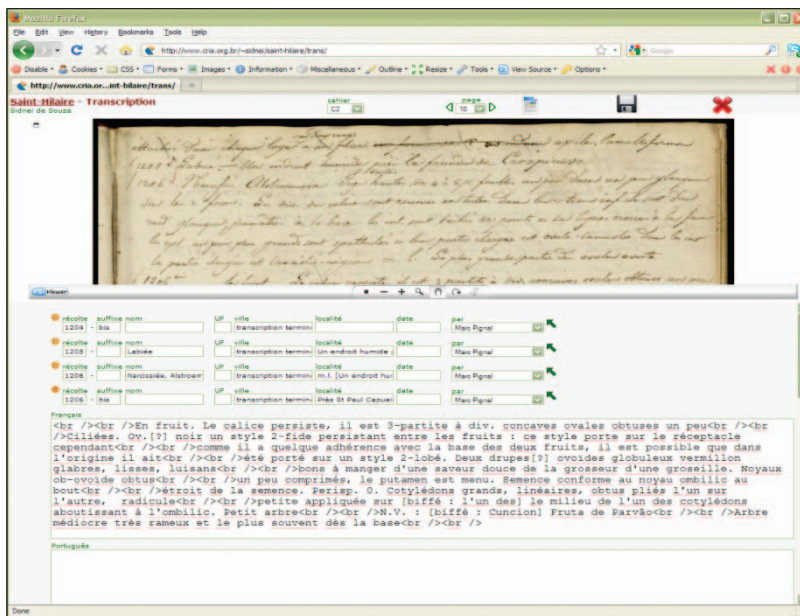


Fig. 3. — Collaborative interface.



Fig. 4. — Saint-Hilaire virtual herbarium presentation. Example of the collection Saint-Hilaire C2-1272, with the field book page and both known vouchers.

is added in SONNERAT, the Virtual herbarium updates the data. Updating is carried out twice a day (see Table 1). This project is linked with the digitization of the Paris herbarium (P). This

general scan is not yet accompanied by computerization which will be gradual. Images and data will be added to the site every time Saint-Hilaire is identified on the label.

TOOLS DEVELOPED

Tools to interact with the site have been made available. The collaborative science tool is used for the transcription of collection numbers and Saint-Hilaire field descriptions. To find images of specimens and corresponding pages of field books, several search tools have been developed.

CITIZEN SCIENCE

AND COLLABORATIVE PARTICIPATION

A collaborative approach is the only way to achieve a complete transcription of all field books in a short amount of time, and Web 2.0 online interfaces using social networks seem to be the most suitable solution. It seemed appropriate to involve enthusiastic botanists as volunteers to help with the transcription. This stage is preliminary for a larger project in order to stimulate the participation of external users in the computerization of the herbaria.

The link between each specimen and each description on the field books was achieved by asking volunteers to list the collection numbers of each page. The list of numbers has been completed.

The system also allows volunteers to transcribe all descriptions and to translate them into Portuguese and English (Fig. 3).

SEARCH BY BARCODE

The system is dynamic and until the completion of the whole work, many records are presented without images, and conversely many images do not have associated data records. Progressively, the proportion of complete sets increases. At the end of the barcode, the icon [s] means that the data exist, the icon [i] means that the image is on the server. Data are complete when both icons appear [si].

SEARCH BY SCIENTIFIC NAMES

Searches for “Family”, “Genus” and “Species” are possible and carried out in all the names included in the history of determinations. It is feasible to select only the type collections, but it is highly recommended to consult all the specimens as the status of type material may not have been spotted in the collection. An example is shown in Figure 4.

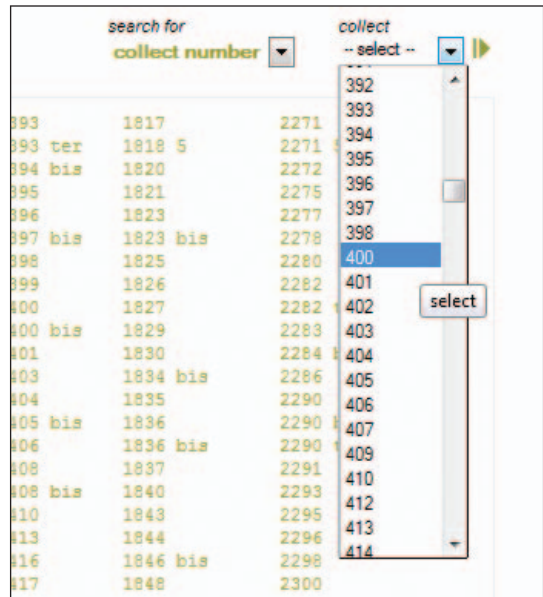


FIG. 5. — Selection of the collection number.

SEARCH BY COLLECTION NUMBER

Collection numbers are the links between the specimens and the field book. It is very important to cite the information correctly in the literature. As seen above, material citation may pose many problems. In all cases, a check of the specimen image and a consultation of the appropriate field book allow to avoid many errors.

METHOD TO CHECK A COLLECTION NUMBER

To identify a collection number and the corresponding field book from a herbarium specimen may be difficult. The virtual herbarium has a tool to quickly view all the pages of field books that register a collection number. Therefore, upon Saint-Hilaire's determination or the description given in a field book, it will often be possible to clarify or validate the corresponding book and letter to be included in the citation.

This tool allows you to select the collection number by clicking on one of the numbers presented in the table or by selecting the numbers presented in a combo (Fig. 5). If the number is not available in the database, you can choose the

TABLE 2. — Field books with collection number. Completed after Dwyer (1955), and notes from the Weddell key.

Field book number	Collection numbers	Notes
A1	1-758	1816: 1-458 and 651-758, in the vicinity of Rio de Janeiro, 470-650, in the vicinity of Uba
A2	464-650 1B-132B	464-650, duplication of A1 1818: Near Rio de Janeiro.
B1	1-63 103-2085	December 1816 to March 1818: 1-25, Province of Rio de Janeiro 26-63, Province of Minas Gerais December 1816 to March 1818: 103-2085, Province of Minas Gerais
B1bis	1-112	Dec. 1816-may 1818 whose series from 63-102 are original
B2	2101-2489 1-408	2101bis-2493, Minas Gerais August to November 1818: Trip from Rio de Janeiro to Rio Doce in the provinces of Rio de Janeiro and Espírito Santo.
B4bis	86-96	
C1	1-60 1-1175	Not Saint-Hilaire handwriting. 1819: 1-10 Province of Rio de Janeiro; 11-625, 926-985, Province of Minas Gerais; September 1819 to May 1820: 626-920, Province of Goias; 986-1175, Province of São Paulo.
C2	1176-1899 2000-2797 1 ^c -219 ^c	May 1820: 1176-1704, Province of São Paulo. May to June 1820: 1705-1806, Province of Santa Catarina. 1820: 1807-1874, 2569-2797 Province of Rio Grande do Sul; 1875-1899, From San Pedro de Rio Grande to Montevideo. 1820: 2000-2260, From San Pedro de Rio Grande to Montevideo; 2261-2568, From Montevideo to the Brazilian frontier on the banks of the Uruguay. Labelled with "c" July 1821: Near Rio de Janeiro.
C3	692-709 1858-1869 2004-2020	September 1819 to May 1820: Goias. 1820: Province of Rio Grande do Sul. 1820: From San Pedro de Rio Grande to Montevideo.
D	1 ^d -818 ^d	Labels with "d" 1820-1821: 1-30 Province of Rio de Janeiro; 31-587 Province of Minas Gerais; 588-818 Province of São Paulo.



FIG. 6. — Result of a search. Several parts are clickable, field book and specimen images for consultation, barcode for Paris Museum site and collection number.



FIG. 7. — Results for collection number.

closest one to your choice. The result is shown in Figure 6.

By clicking on the collection number (A1-400 on the example), all pages containing the number appear and can be enlarged to verify the data (Fig. 7).

To view all books with the same number, simply delete the reference of a field book (Fig. 8).

SAINT-HILAIRE MATERIAL CITATION

HISTORY OF THE NUMBERING

Saint-Hilaire's field books were studied by Dwyer (1955). This work is available on the website at <http://lvsh.cria.org.br/caderno?dwyer>. Dwyer described 18 handwritten field books merged in ten catalogues (see Table 2). As the books were often written during his trips, some of them were copied by Saint-Hilaire later, and some by other people. As Dwyer noted, these num-

bers have only an inventory value and were not cited by Saint-Hilaire in his published work such as *Flora Brasiliae Meridionalis*. However, they may be used today to refer unambiguously to vouchers in collections. In this paper, we propose a standard for material citation.

Heterogeneous in appearance, they are usually organized the same way:

- a collection period at the beginning of each book;
- one number for each collection (each event).

Field identifications

The identifications are often limited to the family, and sometimes genus. These were likely to be field or preliminary determinations. Complete determinations at the end of the description were clearly made later and often concerned the species described by Saint-Hilaire. Even incomplete, these determinations are valuable in the clarification of correspondence between descriptions and specimens.

TABLE 3. — Summary of specimen citations.

		Citation example
A field book number on the sheet		<i>A. de Saint-Hilaire A1-158</i> <i>A. de Saint-Hilaire C3-125^{bis}</i> <i>A. de Saint-Hilaire D-1178⁵</i> <i>A. de Saint-Hilaire s.n., PXXXXXXX</i>
A number, no field book number on the sheet	No number Number inferred from the field book	<i>A. de Saint-Hilaire [A2]-159</i> <i>A. de Saint-Hilaire A [2]-159</i>
A letter without indication of field book	Indication inferred from the website Use brackets The letter does not correspond to any field book	<i>A. de Saint-Hilaire B-159</i> <i>A. de Saint-Hilaire A1-562^{ter}</i>
A number without “bis”, “ter”, “4” mention (after field book verification)	Use brackets	<i>A. de Saint-Hilaire “Milho verde” 55</i>
A letter without a corresponding field book, but mention of a locality on the label attached to the plant		

Description

The descriptions are very accurate in French or Latin, very rarely in Portuguese, sometimes a mixture.

– Vernacular names and uses;

– The collection locality is indicated very briefly at the end of each description, sometimes “m.l.” [“même localité” = same locality] repeated after each description.

For each collecting event, the date is rarely mentioned and field books should overlap with the travel reports published by the naturalist between 1830 and 1851 and the posthumous publication of 1887 (Saint-Hilaire 1830-1851 [1887]).

Collection numbers

There is a greater diversity in the numbering mode. The catalogues can contain multiple series (Table 2), some associated with a suffix “c” or “d”. The use of superscript (bis, ter, 4°, 5° to 12 levels) makes it particularly difficult to estimate the total number of collections.

All descriptions have a collection number, while 59% of the specimens located in the herbarium have no number or no field book reference. Further analysis will tell if these specimens without number can be linked to descriptions.

Some series without numbers have a single locality as e.g., the plants collected in the locality of Olho d’Agoa.

Citation rule

Possibilities are summarized in Table 3. In all cases, the derived data should be cited in brackets.

– 1) The collection number corresponds to a field book called A1, A2, B1...

The collection must be cited:

A. de Saint-Hilaire “Field book reference” - “collection number”. (i.e. *A. de Saint-Hilaire C3-125^{bis}*). Do not forget the suffix, if it exists.

It is necessary to consult the field book to make sure the description matches the specimen. Sometimes the suffix has not been copied to the specimen label.

Be careful: in some cases the letters B and C do not match one of the notebooks. It should be mentioned: *A. de Saint-Hilaire C-254*.

– 2) A collection number occurs, but no field book is mentioned.

Check if the reference relates to a field book (see below the consultation method), whenever numbers have no correspondence with a book. So cite the number: *A. de Saint-Hilaire 251*.

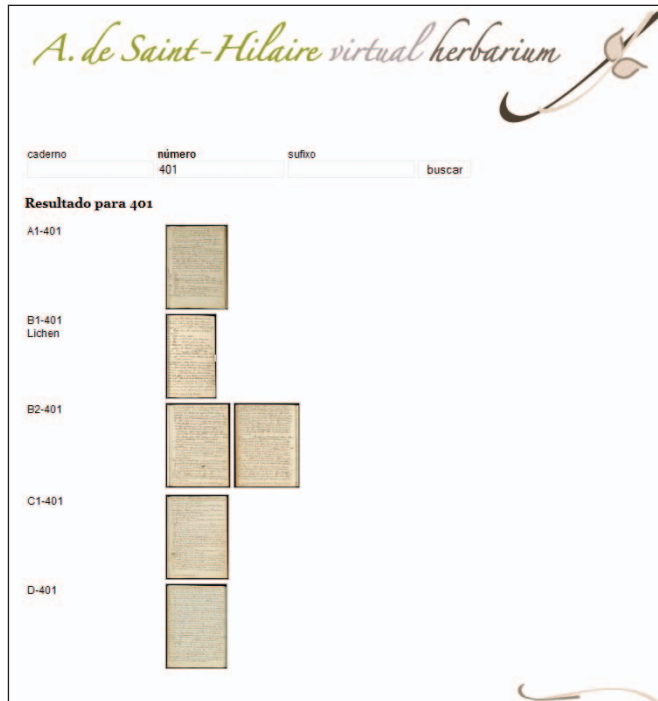


FIG. 8. — All field book pages that mention the collection number 401.

– 3) A collection number exists, no field book is mentioned, but there is information such as the locality on the small label attached to the plant.

Example: *A. de Saint-Hilaire* « *Milho verde* » 55.

Note : some special series exist (i.e. \$C5 at least 180 collection numbers, this numbering should not be confused with a field book reference, a “Cahier C5” never existed).

– 4) No collection number.

A search using the name of the plant may eventually link the specimen to others that have a more complete reference. Specimen from France and the rest of Europe are never numbered. If there is no reference, the specimen must be accompanied by the barcode (*A. de Saint-Hilaire s.n.*, PXXXXXXX; *A. de Saint-Hilaire s.n.*, CLFXXXXXX, etc.).

Weddell catalogue

On some labels, may be an additional number read. This is part of the inventory (assigned to Weddell by Dwyer [1955]). This inventory can be viewed at <http://hvsh.cria.org.br/caderno?weddell>.

ITINERARIES AND LOCALITIES

Several studies exhibit maps of Saint-Hilaire’s itinerary, from which Dwyer (1955) carried out his analysis. His work should refer to Herter’s article (1945: *In the footsteps of naturalists Sellow and Saint-Hilaire*) that is available on-line (<http://hvsh.cria.org.br/caderno?herter>) including the itinerary shown at: <http://hvsh.cria.org.br/caderno?roteiro2>, and a list of localities visited by the two naturalists. Others will follow.

CONCLUSION

The completion of the Saint-Hilaire Virtual Herbarium will be gradual since it follows the databasing rhythm of general herbaria who possess specimens of the botanist. It will benefit other projects that use the SONNERAT database like the scanning of the national French herbarium, the Franco-Brazilian project REFLORA and the French infrastructure e-ReColNat.

The Saint-Hilaire Virtual Herbarium anticipates the development of a new generation of online websites which will facilitate the work in systematic botany. Online access to herbaria pictures, articles and manuscripts spares time and financial resources. In the future, new tools shall be developed in order to increase the system usability and effectiveness. Finally, the system also helps to prepare for consultations of the physical specimens in herbaria, which remain the irreplaceable references in modern botany.

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